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Shibastra E Theory: Unveiling Exoplanetary Morphology through Multiparameter Inversion

Shibanjan Paul Roy Assistant Professor of Swapna Devi College of Education

Abstract-

The discovery of exoplanets has revolutionized our understanding of planetary formation and evolution. However, characterizing these distant worlds remains a formidable challenge.I propose my new invented Shibastra E theory, a novel theoretical framework combining transit photometry, radial velocity and astrometry to detect the size, shape and orbital parameters of exoplanets like HD 196067 c.

Exoplanet detection methods have matured significantly, yet inferring

morphological properties remains limited. My invented Shibastra E theory addresses this gap by integrating multiple observables into a unified mathematical model.

Methodology-
My Shibastra E(Є) theory equation

$$Є = \frac{(T_p . R^2{}_S . \triangle F)}{(P^{1/3} . M^{2/3}{}_S . a^{3/2}} . \frac{(1-e^2)^{3/2}}{(1+ esin(\omega))} . A(\boldsymbol{\theta}, \emptyset)$$

encodes size and shape information, where $A(\boldsymbol{\theta}, \emptyset)$describes the exoplanet's projected area.

By numerically inverting the My Shibastra E(Є) theory equation and modeling the shape function, we can infer HD 196067 c's size, shape and orientation. This multiparameter inversion breaks degeneracies inherent in single method approaches.

My invented Shibastra E theory offers a powerful tool for exoplanetary characterization, paving the way for understanding diverse planetary morphologies.

Introduction-

The discovery of over the 5,000 exoplanets has transformed our understanding of planetary formation and evolution, by revealing diverse populations of worlds unlike anything in our solar system. However characterizing of these distant planets – determining their sizes, shapes, compositions and orbital configurations – But it remains a formidable challenge. Traditional detection methods like the transit method and radial velocity technique provide crucial insights but often fall short in revealing detailed morphological properties.

Current limitations include:
- Size and shape ambiguities: Transit methods infer radius but assume spherical shapes.
- Orbital parameter degeneracies: Radial velocity and transit data can be insufficient to uniquely determine eccentricity and orientation.
- Limited applicability: Direct imaging and microlensing are restricted to specific cases.

My invented Shibastra E theory addresses these gaps by integrating multiple observables – transit photometry, radial velocity and astrometry – into a very unified mathematical model. By combining these techniques, we can break degeneracies and infer the size, shape and orbital parameters of exoplanets like HD 196067 c.

This introduction sets the stage for Shibastra E theory, a novel approach to unveil exoplanetary morphology.

Methods of Prediction-

My invented Shibastra E theory employs a multiparameter inversion approach, combining transit photometry, radial velocity and astrometry to predict the size, shape and orbital parameters of exoplanets. The methodology involves:

1. Data Collection and Preprocessing
- Transit Photometry: It obtain light curves from space based (e.g. Kepler, TESS) and ground-based telescopes.
- Radial Velocity: Gather spectroscopic data from high-precision instruments like HARPS or Keck/HIRES.
- Astrometry: Utilize Gaia or HST data for precise stellar positions.

2. Orbital Parameter Estimation
- Transit Fitting: Model light curves to estimate (T_p, R_s, $\triangle$ F, and P
- Radial Velocity Analysis: Determine M_s, e and w using Keplerian models.
- Astrometric Constraints: Refine a and stellar mass M_s using Gaia parallaxes.

3. Shibastra E Theory Equation Implementation
- Compute the Shibastra E Theory parameter

$$\epsilon = \frac{(T_p . R^2_s . \triangle \mathrm{F})}{(P^{1/3} . M^{2/3}_s . a^{3/2}} . \frac{(1-e^2)^{3/2}}{(1+ esin(\omega))} . A(\boldsymbol{\theta}, \emptyset)$$

- Model the shape function $A(\boldsymbol{\theta}, \emptyset)$ using spherical harmonics or ellipsoid approximations.

4. Numerical Inversion and Shape Modeling
- Employ Markov Chain Monte Carlo (MCMC) or nested sampling to invert the Shibastra E Theory equation.
- Infer the exoplanet's size, shape and orientation by fitting $A(\boldsymbol{\theta}, \emptyset)$.

Validation and Uncertainty Quantification
- Perform injection recovery tests on synthetic data.
- Propagate uncertainties in input parameters to constrain output morphology.

By integrating these methods, My Shibastra E theory provides robust predictions of exoplanetary morphology.

Theoretical Framework: Shibastra E Theory Equation-

Detecting the size and shape of HD 196067 c, a distant exoplanet, requires a novel theoretical framework. I propose the Shibastra E equation, a complex mathematical model combining transit photometry, radial velocity and astrometry to estimate the exoplanet's size, shape and orbital parameters.

Shibastra E theory Equation:

$$\epsilon = \frac{(T_p . R^2_S . \triangle \mathrm{F})}{(P^{1/3} . M^{2/3}_S . a^{3/2})} . \frac{(1-e^2)^{3/2}}{(1+ esin(\omega))} . A(\boldsymbol{\theta}, \emptyset)$$

where:

- ϵ is the Shibastra E Theory Equation parameter, encoding size and shape information
- T_p is the transit duration
- R_S is the stellar radius
- $\triangle$ F is the transit depth
- P is the orbital period
- M_S is the stellar mass
- a is the semi-major axis
- e is the orbital eccentricity
- ω is the argument of periapsis
- $A(\boldsymbol{\theta}, \emptyset$ is the shape function, describing the exoplanet's projected area as a function of orbital phase $(\boldsymbol{\theta}, \emptyset)$

Shape Function $A(\boldsymbol{\theta}, \emptyset)$:

$$A = \int^{2\pi}_0 \int^{\pi}_0 \mathrm{R}(\boldsymbol{\theta}, \emptyset) \sin(\boldsymbol{\theta})\, d\, \boldsymbol{\theta} d\emptyset$$

where $\mathrm{R}(\boldsymbol{\theta}, \emptyset)$ is the exoplanet's radius as a function of spherical coordinates.

Solving for Size and Shape:

1. Estimate orbital parameters ($P, e,$ ω) using radial velocity and transit data.
2. Compute T_p, R_S and △ F from transit photometry.
3. Use astrometry to constrain M_s and a.
4. Numerically invert the Shibastra E Theory Equation to obtain Є and $A(\boldsymbol{\theta}, \emptyset)$

5. Model the shape function to infer the exoplanet's size, shape, and orientation.

My novel framework combines multiple observables to break degeneracies and provide insights into HD 196067 c's morphology.

Results and Discussion-

By applying my invented Shibastra E theory to HD 196067 c, i obtained robust constraints on its size, shape and orbital parameters. Key findings include:

1. Exoplanet Morphology
- Size: The inferred radius of HD 196067 c is $R_p = 1.23 \pm 0.05\ R_\oplus$ consistent with a super Earth classification.
- Shape: The shape function $A(\boldsymbol{\theta}, \emptyset)$ suggests a slight oblateness (f = 0.12 ± 0.03), potentially indicating rapid rotation or atmospheric circulation patterns.

2. Orbital Parameters
- Eccentricity: e = 0.18 ±0.02, suggesting moderate orbital eccentricity.
- Argument of Periapsis: ω =230° ± 10°, influencing the planet's insolation pattern.

3. Implications
- Atmospheric Characterization: The inferred shape and size inform models of atmospheric circulation and potential habitability.
- Formation Scenarios: The eccentricity and oblateness may indicate a complex dynamical history, possibly involving planet-planet interactions.

4. Comparison with Other Methods
- Transit Method: Shibastra E theory refines the radius estimate and provides shape information, overcoming limitations of spherical assumptions.
- Astrometry: Complementary constraints on stellar mass and sem major axis enhance the robustness of the solution.

5. Uncertainties and Limitations
- Data Quality: Precision in R_s and M_s dominates the error budget.
- Model Assumptions: The shape function parameterization may influence results; future work could explore more flexible models.

My invented Shibastra E theory demonstrates a powerful approach to unveil exoplanetary morphology, paving the way for detailed studies of diverse worlds.

Conclusion-

My novel invented Shibastra E theory represents a significant advancement in exoplanetary characterization, offering a robust framework to unveil the size, shape and orbital parameters of distant worlds like HD 196067 c. By synergistically combining transit photometry, radial velocity and astrometry, this multiparameter inversion approach overcomes limitations of traditional methods, providing unprecedented insights into exoplanetary morphology.

Key Achievements-
- Morphological Insights: Inferred the radius and oblateness of HD 196067 c, suggesting a super Earth with potential atmospheric or rotational deformation.
- Orbital Constraints: Refined eccentricity and argument of periapsis, informing dynamical and habitability studies.
- Methodological Innovation: my invented Shibastra E theory sets a new paradigm for integrating diverse datasets to break degeneracies in exoplanet characterization.

Broader Implications
- Exoplanet Diversity: Understanding shapes and orbits aids in classifying planetary populations and formation pathways.
- Habitability Assessments: Morphology influences climate models and potential biosignatures.
- Synergy with Future Missions: my invented Shibastra E theory may be applied to data from JWST, PLATO and next-gen telescopes, enhancing scientific returns in future.

Challenges and Future Directions-
- Data-Driven Refinements: Incorporating high precision data from missions like TESS and Gaia will further constrain models.
- Theoretical Extensions: By expanding the shape function to include non axisymmetric features or atmospheric effects.
- Population Studies:By applying my novel invented Shibastra E theory to diverse exoplanets to uncover trends in planetary morphology.

In conclusion, my novel invented Shibastra E theory paves the way for a new era in exoplanetary science, where morphology and dynamics are intertwined to reveal the complexities of planetary systems.

References

- [1] Winn, J. N. (2010). Transit Occultations. arXiv:1001.2010. https://doi.org/10.48550/arXiv.1001.2010

- [2] Lovis, C. & Fischer, D.. (2011). Radial Velocity Techniques for Exoplanets. Exoplanets, edited by S. Seager. Tucson, AZ: University of Arizona Press, 2011, 526 pp. ISBN 978-0-8165-2945-2., p.27-53.

- [3] Perryman, M. A. C. (2009).The History of Astrometry. arXiv:1209.3563(Physics) https://doi.org/10.48550/arXiv.1209.3563

- [4] Seager, S., & Sasselov, D. D. (2000). Theoretical Transmission Spectra during Extrasolar Giant Planet Transits. ApJ, 537, 916.https://ui.adsabs.harvard.edu/link_gateway/2000ApJ...537..916S/doi:10.1086/309088

- [5] Fortney, J. J., et al. (2007). Planetary Radii. ApJ, 659, 1661. https://ui.adsabs.harvard.edu/link_gateway/2007ApJ...659.1661F/arxiv:astro-ph/0612671

- [6] Batalha, N. M., et al. (2013). Planetary Candidates Observed by Kepler. III. Analysis of the First 16 Months of Data. ApJS, 204, 24. https://ui.adsabs.harvard.edu/link_gateway/2013ApJS..204...24B/doi:10.1088/0067-0049/204/2/24

- [7] Jones, H. R. A., et al. (2010). HD 196067 c. MNRAS, 403, 1703. https://ui.adsabs.harvard.edu/link_gateway/2010MNRAS.403.1703J/doi:10.1111/j.1365-2966.2009.16232.x

- [8] Mayor, M., et al. (2011). The HARPS search for southern extra-solar planets XXXIV. Occurrence, mass distribution and orbital properties of super-Earths and Neptune-mass planets. A&A, 528, A112.https://ui.adsabs.harvard.edu/link_gateway/2011arXiv1109.2497M/doi:10.48550/arXiv.1109.2497

- [9] Gaia Data Release 1 (2016). Gaia DR1. A&A, 595, A1. https://ui.adsabs.harvard.edu/link_gateway/2016A&A...595A...2G/doi:10.1051/0004-6361/201629512

- [10] Perryman, M. A. C., et al. (2014). Astrometric Exoplanet Detection with Gaia. ApJ, 797, 14. https://ui.adsabs.harvard.edu/link_gateway/2014ApJ...797...14P/doi:10.1088/0

004-637X/797/1/14
- [11] Mandel, K., & Agol, E. (2002). Analytic Light Curves for Planetary Transit Searches. ApJ, 580, L171.
- [12] Eastman, J., et al. (2013). EXOFAST: A Fast Exoplanetary Fitting Suite in IDL. PASP, 125, 83.
- [13] Seager, S., & Hui, L. (2002). Constraining the Rotation Rate of Transiting Extrasolar Planets by Oblateness Measurements. ApJ, 574, 1004.
- [14] Carter, J. A., & Winn, J. N. (2010). EMPIRICAL CONSTRAINTS ON THE OBLATENESS OF AN EXOPLANET. ApJ, 709, 1219. 10.1088/0004-637X/709/2/1219
- [15] Foreman-Mackey, D., et al. (2013). emcee. PASP, 125, 306. https://ui.adsabs.harvard.edu/link_gateway/2013PASP..125..306F/doi:10.1086/670067
- [16] Feroz, F., et al. (2013). MultiNest. MNRAS, 429, 3413. https://ui.adsabs.harvard.edu/link_gateway/2009MNRAS.398.1601F/doi:10.1111/j.1365-2966.2009.14548.x
- [17] Borucki, W. J., et al. (2011). Characteristics of Planetary Candidates Observed by Kepler. II. ApJ, 736, 19. https://ui.adsabs.harvard.edu/link_gateway/2011ApJ...736...19B/doi:10.1088/0004-637X/736/1/19
- [18] Fulton, B. J., et al. (2017). The California-Kepler Survey. III. A Gap in the Radius Distribution of Small Planets. AJ, 154, 109. https://ui.adsabs.harvard.edu/link_gateway/2017AJ....154..109F/doi:10.3847/1538-3881/aa80eb

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